DOCUMENT RESUME

ED 184 019 CG 014 249

AUTHOR Durio, Helen F.
TITLE The Measurement of Mental Imagery Ability: Single or Multidimensional Construct?
PUB DATE 79
NOTE 28p.; Paper presented at the Annual Convention of the American Psychological Association (87th, New York, NY, September 1-5, 1979).

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Adults; Analysis of Variance; Aptitude; Attribution Theory; *Cerebral Dominance; *Cognitive Ability; *Imagery; *Measurement Techniques; *Nonverbal Ability; Performance; Research Projects; *Visual Perception

ABSTRACT

The suggestion of an underlying dimension in mental imagery despite low correlations among objective spatial and self report measures was investigated using data from two independent samples of 131 college students. The first study revealed some factorial independence in imagery aptitude, while the second study investigated individual patterns of imagery ability in four mutually exclusive groups through analysis of variance procedures with repeated measures on four cognitive tasks. Interpretations from results of these two studies tentatively support differential attributes. Neurological literature suggests that: (1) major components of nonverbal cognition may be mental manipulation of external objects in space, imaginal body movements, and nonverbal conceptual representations; (2) this diversity complicates the construct of mental imagery; and (3) different neural centers in both left and right hemispheres are probably being tapped in various operationalizations of imagery aptitude. (Author)

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THE MEASUREMENT OF MENTAL IMAGERY ABILITY: SINGLE OR MULTIDIMENSIONAL CONSTRUCT?

by

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* A version of this paper will be presented to Division 15 at the National Convention of the American Psychological Association in New York City, 1979.

CG 014249

THE MEASUREMENT OF MENTAL IMAGERY ABILITY: SINGLE OR MULTIDIMENSIONAL ATTRIBUTE?

The idea that images are vital to thought captured the attention of early psychologists, Fechner, Wundt, Galton, James, and Titchener; but as American behaviorism rose in importance, access to reports of mental imagery became suspect. The study of human thought was considered too introspective in nature. In the last decade, there has been a decline in the influence of strict behaviorism, and the study of mental imagery as a nonverbal coding system has returned to occupying time and effort of psychologists in the United States interested in human cognition.

The measurement of individual differences in the ability to use mental imagery has proven complex. Some of the difficulty stems from the fact that the construct of mental imagery has not been clearly defined in terms of a domain of observable behaviors. The term "imagery" is used to refer to both a product and a process. As a product, it is a nonverbal cognitive representation. As a process, it is a cognitive function. This duality produces confusion in measurement. In addition, the construct of spatial aptitude is confounded with that of mental imagery.

Ernest (1977) has categorized the attempts to measure imagery ability into three classes, 1) self-ratings, 2) spatial measures, and 3) performance measures.

Self-ratings of the vividness of one's imagery include Sheehan's (1967) modification of Betts (1909) Questionnaire upon Mental Imagery; Gordon's Test of Visual Imagery Control (A. Richardson, 1969);

Paivio's (1971) Individual Differences Questionnaire; and Marks' (1973) Vividness of Visual Imagery Questionnaire. DiVesta, Ingersoll, and Sunshine (1971) have criticized such self-ratings of imagery as being contaminated with a social desirability response bias, but Ernest takes exception to this view. Ernest cites A. Richardson's (1977) finding that Gordon and Paivio self-ratings are relatively free of response bias. Durio (1978) suggests that investigators can avoid the major effects of a social desirability response bias by using a mediation self-report format on a verbal to nonverbal continuum, rather than self-ratings of image intensity.

Spatial measures of imagery involve mental rotations of spatial relationships. Tests such as the Minnesota Paper Form Board (Likert & Quasha, 1941), Space Relations (Bennett, Seashore, & Wesman, 1947), and Flags (Thurstone & Jeffrey, 1956), have all been used to isolate imagery spatial aptitude. The thesis that these tests appear to be measuring a common nonverbal domain of analytical spatial reasoning is projected in this paper.

A variety of performance tasks have been operationalized in imagery research, usually dealing with the speed of image generation or efficacy in recall of a projected stimulus. Performance measures seem to suggest greater individual differences are found in imagery processing of abstract rather than concrete stimuli (J. Richardson, 1975; Durio, 1978), which reflects the stronger tendency for all persons to mediate concrete stimuli imaginally while reserving the verbal system for processing abstract stimuli (Paivio, 1971). Thus, it appears it is nonverbal coding with

abstract stimuli which best isolates individual tendencies toward imaginal coding. It has been found also that imagery use in abstract contexts is related to creative aptitude (Durio, 1978; 1979).

In reviewing the pertinent imagery literature, Ernest (1977) has addressed the question of whether so many different types of imagery assessment are measuring the same underlying ability. Low correlations among performance imagery tests have been found, but sets of imagery self-ratings correlate moderately among themselves, as do sets of objective spatial measures. Ernest feels that self-ratings and spatial tests may not be independent, despite factor analyses to the contrary (DiVesta, Ingersoll, & Sunshine, 1971). Ernest theorizes that curvilinearity may mask a true relationship existing among individuals, though Ernest does not define the nature of such an hypothesized relationship.

The question of whether imagery is more the single dimension suspected by Ernest, or a multidimensional attribute, will be addressed in two studies. The earlier study was part of an ongoing investigation into imagery, originality, and creativity (Durio, 1975; 1978; 1979; Durio & Walker-Batson, 1978). The second study was undertaken recently in an attempt to clarify the findings of factorial independence in imagery abilities in analyzing previous studies. Specifically, there was interest in investigating a pattern of analytical skill in use of imagery (i.e., rotating objects in space), along with the coding propensity to use imagery spontaneously. One might consider these two patterns as reflecting somewhat bipolar analytical-holistic dimensions, or perhaps convergent-divergent distinctions. More precisely, a dichotomy was hypothesized between spatial analytical functioning and imaged thought.

STUDY 1

Procedures

Eighty nine undergraduates in the University of Texas at Austin were given a variety of cognitive measures and tasks to perform in small groups for purposes of investigating the relationship between creativity and imagery. The analyses to be reported here are correlational and factor analysis statistical treatment of the data from this earlier study. Instruments used in Study 1 were:

1. Guilford's Making Objects (1977), indicative of figural divergent thinking.

2. Guilford's Similies (1977), indicative of semantic divergent thinking.

3. Torrance's Unusual Uses (1974), assumed to reflect general creative aptitude.

4. Creativity Self Rating. Self-ratings on a seven point scale running from the continuum of "my thinking processes are much like everyone else's" to "my thinking processes are quite unlike others," and self ratings on another seven point scale for the continuum of "my thoughts are seldom useful" to "my thoughts are always useful" were summed for each subject to obtain a creativity self rating. This approach was taken to avoid a potential social desirability response set in use of the term "creativity." Originality and relevancy are two attributes considered necessary in defining creative behavior (Gilchrist, 1972).

5. Self-Rating as to Dominant Coding Style was obtained by a seven point scale running from verbal to nonverbal thinking preference.

6. The number of Nonverbal Spatial Activities enjoyed and engaged in

regularly was obtained through a checklist of activities associated commonly with right hemispheric functioning (i.e., playing music by ear, dancing freely to music, sculpting, potting, etc.).

7. The number of Verbal Analytical Activities enjoyed and engaged in regularly was obtained from a checklist of activities associated usually with left hemispheric functioning (i.e., writing, speaking, chess, mathematical probabilities, logical analysis, etc.).

8. Cubes (Thurstone, 1977), a block rotation measure, which reflects spatial visualization skill in manipulating external objects mentally.

Another twelve variables were obtained through presentation of ten concrete and ten abstract figures, and ten concrete noun pairs and ten abstract noun pairs, in a free association task. Examples of concrete figures were recognizable drawings, such as a house, baby, or book; and examples of abstract figures were unrecognizable crossed lines, curves, or circles which could have more than one symbolic meaning. An example of a concrete noun pair is lark-accordian, and an example of an abstract noun pair is moral-hope. The 20 most concrete and the 20 most abstract nouns from the 1968 list of Paivio, Yuille, and Madigan of 925 nouns rated for Concreteness, Meaningfulness, and Imageability, which could be equated for average Meaningfulness (number of associations generated), were selected. Subjects were asked to give their immediate free association to figures in writing, and to suggest in writing a mnemonic link for each noun pair. Stimulus items were presented in 30 second intervals. Three criterion variables for concrete and abstract figures and three criterion variables for concrete and abstract noun pairs were obtained from these free response tasks, 1) judged ratings of free response originality, 2) number of

imagery mediators reported, and 3) judged ratings of the concreteness of overt free responses.

The ratings of originality were obtained from averaging the scores from three independent judges as to the level of response originality of each student's written overt free association on a nine point scale for each of the 40 figures and nouns. Originality was defined as statistical infrequency or novelty of response within the sample. Separate ratings were tallied and maintained for response originality to concrete figures, abstract figures, concrete nouns, and abstract nouns.

The response concreteness ratings were obtained from averaging the ratings of three independent judges for each subject's written overt free response to the 40 stimulus items. Concreteness was defined in terms of Paivio, Yuille, and Madigan's definition of concreteness as proximity to an objective referent. Ratings were then tallied separately for response concreteness to concrete figures, abstract figures, concrete nouns, and abstract nouns.

Reports of imagery mediation were tallied for concrete figures, abstract figures, concrete nouns, and abstract nouns separately from the self-reports of subjects' mediators as they free associated to the 40 stimulus items. Subjects were given instruction and practice examples before the task as to what is meant by verbal and nonverbal mediators. On the task, they were asked to check whether their initial overt free response reported to each stimulus was being mediated verbally or nonverbally.

STUDY 2

Procedures

Forty two undergraduates from a church affiliated university in Austin, Texas were administered the block rotation spatial measure, "Cubes," (Thurstone, 1944), and presented with 40 nouns to which they were asked to check whether their immediate mediation type was verbal or nonverbal for purposes of investigating different patterns of imaginal processing. The numbers of nonverbal associations were tallied for each subject across the 40 nouns. Nouns consisted of 20 concrete and 20 abstract words from the list of Paivio, Yuille, and Madigan (1968). Raw scores were standardized on both imagery distributions for subjects, and four mutually exclusive imagery ability groups were formed by splitting each distribution at the median and combining into 1) low objective spatial imagery and low self-report 2) low objective spatial imagery and high self-report imagery, 3) high objective spatial imagery and low self-report imagery, and 4) high objective spatial imagery and high self-report imagery.

Groups were administered four tasks:

1) Paired associate learning of 10 concrete and 10 abstract noun pairs from the list by Paivio, Yuille, and Madigan as a reflection of verbal memory skill.

2) Memory for design. 20 designs were adapted from the Maitland Graves Design Judgment Test (1946) as a reflection of nonverbal memory skill.

On memory tasks, subjects were presented with each set of stimuli for ten minutes. They were asked to supply the second word of each

noun pair in the verbal memory task, and on the nonverbal memory task to indicate whether each design of a second presentation of 20 designs had been seen earlier, or was new to them. Half of the designs were new, in that they were the paired preference choice on the Maitland Graves judgment test.

3) Guilford's Similes as reflection of semantic verbal divergent thinking.

4) Guilford's Making Objects, as reflection of figural nonverbal divergent thinking.

Raw scores were standardized and analysis of variance techniques applied to the data in a 2 x 2 x 4 fixed effects design. Between subject factors were two levels of objective spatial imagery ability and two levels of self-report imagery ability. Within subject factors were the four types of cognitive tasks.

RESULTS

Table 1 contains two intercorrelation matrices for variables in Study 1 and variables in Study 2. Both Tables reveal negative or low correlations between self report measures of imagery and spatial block rotation measures. In general, the more abstract the stimulus item in prompting spontaneous self-report of imagery mediation, one finds less relationship to block rotation skill.

The results of the factor analysis for Study 1 are shown in Table 2.

Imagery aptitude as measured by the block rotation test, Cubes, did not cluster with self-reports of imagery mediation when all variables were subjected to factor analysis and Varimax Rotation. The three factors which emerged might be called 1) Imagery Mediation to Nouns, represented by imagery mediation reports and response concreteness to concrete and abstract noun pairs; 2) Common Response Tendency, represented by negative loadings on response originality; and 3) divergent thinking, represented by loadings on instruments of Guilford and Torrance.

The previously cited factorial investigation of mental imagery by DiVesta, Ingersoll, and Sunshine (1971) supported objective spatial measures of mental imagery as being less susceptible to a social desirability response bias than self-ratings of imagery. They called the factor upon which spatial tests loaded "Imagery," and the factor upon which imagery self ratings loaded, "Social Desirability," due to inclusion of loadings on that factor of a social desirability measure.

However, the self-ratings used by DiVesta et al. were of imagery intensity. With the procedures of this study there is no reason to believe that subjects felt imagery mediation to be a more desirable response than verbal mediation. No questions were asked about the intensity of either type of mediation which might have induced a social desirability response bias. Additionally, procedures required that when subjects reported their type of medition they had to respond concurrently with an overt free response, indicative of their processing of stimulus items. Yet unexpected inverse or null relationships were found between spatial aptitude and total imagery mediation reports as operationalized in this study ($r = -.157$). The block rotation test and the imagery end of the dominant coding style self-rating were unrelated also ($r = -.06$). These results do not support the DiVesta

et al. assumption that an objective spatial aptitude measure is a more valid indicator of imagery usage or imagery ability. When forced choice or continuum self-report measures are used instead of imagery intensity self-ratings to alleviate bias, one still finds independence between spatial and self-report imagery tasks.

Table 3 indicates that no significant differences emerged between the mutually exclusive high and low spatial and high and low self-report imagery ability groups across all imagery tasks in Study 2. However, it is worth noting that there was a near significant main effect between the high and low levels of the self-report imagery group ($P = .09$) in favor of the high subjects across all tasks. The cell means from the interaction of self-report and task reveals higher scores were obtained by the high self-report subjects on the divergent thinking tasks than on the memory tasks ($P = .08$). Though the main effect for high and low objective spatial imagery was not significant across four tasks, inspection of cell means in Table 4 reveals that persons scoring high on the block rotation measure and low on the self-report measure did better on the memory tasks than divergent thinking tasks. The converse was seen in the low spatial/high self-report group

Table 4 provides the means and standard deviations of each of the four mutually exclusive groups on all four cognitive tasks from the objective spatial x self-report x type of task interaction cells. It is interesting that persons scoring low on both objective and self-report imagery measures did slightly better on the paired associate learning task. While not a significant difference, this is the only task in which higher scoring imagery aptitude was not an advantage. Despite the general conclusion that imagery

is a useful mnemonic, this result has been found before (Stewart, 1965; Ernest & Paivio, 1971; Anderson, 1973; J. Richardson, 1976). Stewart found that female subjects with low imagery ability as defined by a spatial measure were superior in word recognition but not picture recognition. Ernest and Paivio also found female low imagers exceeding high imagers on word recall, and Anderson found poorer recall in high imagers as determined by a spatial relations test, regardless of sex.

Some of the conflict over the value of imagery vs. verbal coding for recall found in the literature may result from the fact that low imagery ability has been equated to high verbal encoding in individuals in many studies. Only in a few studies has a measure of verbal encoding been operationalized. A dichotomy between use of the imaginal and verbal coding system by virtue of only an imagery measure is undoubtedly over simplified. Low imagers probably do not use verbal coding strategies with equal ease, and sex differences might even be implicated.

DISCUSSION

Ernest, in the previously cited review of imagery studies theorized about an underlying imagery attribute among the diverse measures of mental imagery. No clear supportive evidence for this single dimension was offered, however.

In this research correlation coefficients were low and negative between objective spatial imagery and self-report imagery in both studies. Though no significant differences were found in the mutually exclusive imagery ability groups in Study 2, there were sufficient directional trends found to suggest that some cognitive tasks are more associated with objective

spatial measures, and other cognitive tasks more associated with self-report imagery measures.

Neurological Support for Differential Attributes in Mental Imagery

Findings from neurological research suggest that major functional sub-components of nonverbal thinking may well be an imaginal reasoning about spatial relationships involving external objects and imaginal internal body movements in space, in addition to the nonverbal coding of conceptual relationships which serve as imaginal representations or mediators in thought. If functions located in different brain centers are being tapped, this could explain the low correlations between self-report and objective spatial measures of imagery. Table 5 provides a summary of the various types of instruments used to infer three components of nonverbal skill.

Imagery in general has been thought to be more of a right hemisphere function as it involves visuo-spatial processing centers located in the right hemisphere (of right handed persons), while language functions have been found to be properties of the left hemisphere (Kimura, 1976). Yet there is current neurological evidence to support the belief that most cognitive functions activate neural centers in both hemispheres simultaneously (Lassen, Ingvar, & Skinhøj, 1978). It has been noted that when processing of spatial information requires frontal lobe intellectual analysis, the contribution of the left hemisphere increases (DeRenzi, 1978). The brain centers for imaginal manipulation of internal body space also appear to involve both hemispheres. Lassen, Ingvar, and Skinhøj found separate centers in both hemispheres were activated for imaginal body

movements and actual performance of body movement as demonstrated by mapping of blood flow. While research can be cited which supports right hemispheric specialization for spatial functioning, other research has found involvement of both hemispheres on spatial tasks. Dick (1976) reviews literature showing that while the right hemisphere may be superior for many spatial tasks, patients with right brain damage and intact left hemispheres have been found capable of performing some spatial tasks. Dick concludes that there are two spatial systems, which he refers to as "egocentric" and "retinotopic." The retinotopic system is involved in relating objects in space to one another, while the egocentric system is involved in orienting one's body in space in relation to objects. He feels that the localization of the retinotopic spatial system is not confined to the right hemisphere.

Though several investigators agree that there is a spatial system dichotomy, conflicting opinions can be found as to the hemispheric location of specified spatial skills (Butters, Soeldner, & Fedio, 1972; Kohn & Dennis, 1972). Butters, Soeldner, and Fedio relate right parietal lesions with errors in mentally rotating external objects such as on the Match Stick Test, or spatial manipulation measures used in imagery assessment. In rotation of internally generated images and kinesthetic personal space, they feel the left frontal area of the brain is implicated. Lesions in this area will produce errors of judgment in personal space or impairment of performance on measures such as the Money Road Map Test, which requires rotation of internally generated images. Kohn and Dennis (1974) found contrasting results. It was their finding that internal body space is more related to critical regions in the right hemisphere and external space associations involve

sites in both hemispheres. Luria (1966) has suggested that frontal lobe deficits impede all logical operations, and certainly logical reasoning is involved in manipulating objects such as is necessary on an objective spatial measure. Thus Luria's interpretation would involve both hemispheres in the logical relationships of Dick's retinotopic spatial associating of objects with one another, and be consistent with Kohn and Dennis' data.

Krashen (1976) reviews studies that report nonverbal function in the left hemisphere to support the view that there are mental abilities that underlie both linguistic and nonlinguistic functions. For instance, the left hemisphere is thought to be more specialized for associative thought and identification of meanings, whether verbal or nonverbal. Persons with left lesions perform more poorly than persons with right lesions on object matching tasks requiring some logical association (i.e. a picture of a church with the sound of a bell). If nonverbal functioning is confined to the right hemisphere, then persons with right lesions should suffer the disadvantages on an object matching test. The left hemisphere is also specialized for temporal order nonverbal judgments, such as sequencing of sounds and lights. Krashen reports that an area in both hemispheres is needed for success on the Raven Test. The retro-rolandic region of the right hemisphere, which is specialized for intellectual processing of visual data, and an area of the left hemisphere overlapping the language area, are both thought to be involved in performance on the Raven.

Krashen's view is supported by the fascinating studies in brain function and blood flow (Lassen et al, 1978) indicating that a network of discrete neural centers located in different parts of the brain contribute to

one complex mental activity. For instance, seven discrete cortical regions are simultaneously active in each hemisphere when reading aloud. Each sensory modality is activated by primary centers in the cortex and adjacent memory association area, but are not confined to one hemisphere. The increasing sophistication of neurological mapping of neural activity in mental functioning promises fuller explanation of cognitive processes, which will result ultimately in a clarification of terminology.

Summary

The possibility of an underlying dimension in mental imagery despite low correlations among three operationalized approaches (self-ratings, spatial tests, and performance tasks) to measurement of imagery ability has been suggested by Ernest (1977). To date, however, operationalizations of imagery seem to reflect somewhat different specialities. The present investigation considers data from two studies in which nonverbal cognitive processing of 131 undergraduates (84 females, 47 males) is examined. Imagery ability was operationalized by two independent measures, mental block rotation and free association imagery mediation reports. Study 1 revealed factorial independence of imagery aptitude measures, suggesting a possible spatial analytical use of imagery as opposed to spontaneous personal nonverbal processing. Study 2 investigated these patterns further through the formation of four mutually exclusive groupings of high and low spatial and high and low self-report imagery ability distributions. Group differences on four verbal and nonverbal tasks of memory and divergent thinking were analyzed through analysis of variance procedures in a repeated measures design. The interaction results from Study 2 suggest some support for an effect from high self-report imagery mediation on divergent thinking ($P = .08$) and a high objective spatial imagery ability effect on memory for designs ($P = .15$). The high spatial /high self-report imagery group had higher mean scores than the other three groups on all measures with the exception of the paired associate learning task.

There is neurological support for nonverbal processing as involving at least three functional components, mental rotation of external objects,

spatial associations involving one's body, and spontaneous nonverbal mediation (Dick, 1976; Krashen, 1976; DeRenzi, 1978; Lassen, Ingvar, & Skinhøj, 1978). External spatial relationships, such as needed on objective spatial measures requiring logical mental manipulation and rotation of external objects, seem to require frontal lobe participation from both hemispheres. Imagined body movements involve the supplementary motor area in both hemispheres, and the complexity of nonverbal representations in cognition suggest involvement of multi-brain centers, also. Even though imagery has been assumed more a right hemisphere function, recent investigations into blood flow (Lassen, et al, 1978) suggest that a network of discrete neural centers located in different parts of the brain contribute to one complex mental activity. The activation of the various centers would depend upon the complexity of the task. The tapping of different brain centers on diverse nonverbal tasks could explain the low correlations between different types of imagery instruments.

Undoubtedly the terminology currently in use to refer to nonverbal processes is in need of delimiting. Yet an attempt to analyze mental imagery must integrate neurological findings with those of cognitive psychology and linguistics. Until the construct of mental imagery is refined further, it is recommended that assessment include both spatial and self-report items.

TABLE 1

INTERCORRELATION

Study 1

	1	2	3	4	5	6
Imagery Self Reports to:						
1. Concrete figures	1.00	.599*	.192	.266*	-.044	.249*
2. Abstract figures		1.00	.206	.478*	-.001	.280*
3. Concrete nouns			1.00	.628*	-.153	.391*
4. Abstract nouns				1.00	-.221*	.349*
5. Objective Spatial Block Rotation					1.00	-.061
6. Self-Rating Dominant Coding Style [Lo=Verbal] [Hi=Imagery]						1.00

.207 < P.05
.270 < P.01

Study 2

	1	2	3	4
Imagery Self Reports to:				
1. Concrete nouns	1.00	.275	-.038	.014
2. Abstract nouns		1.00	-.018	.198
3. Objective Spatial Block Rotation			1.00	.238
4. Self-Rating Dominant Coding Style [Lo=Verbal] [Hi=Imagery]				1.00

.304 P <.05
.393 P <.01

TABLE 2

Varimax Rotation Factor Loadings on 20 Variables

Variable	I Imagery/Concreteness to Nouns	II Common Response Tendency	III Divergent Thinking
DT_F	.1156	-.3388	.5331
DT_S	.0227	.0294	.4881
UU	.1003	.1358	.5319
SPT_{APT}	-.3037	.0364	.3531
RO_{CF}	.1285	-.7131	-.1078
RO_{AF}	.1578	-.7151	-.1147
RO_{CNP}	.3477	-.3787	.1348
RO_{ANP}	.6126	-.4142	-.0130
RC_{CF}	-.0986	.4083	.1717
RC_{AF}	.1660	.0707	.3190
RC_{CNP}	.3917	-.1020	.2719
RC_{ANP}	.6779	.0056	.0617
IMR_{CF}	.3613	-.0041	-.1505
IMR_{AF}	.4734	-.0826	.1007
IMR_{CNP}	.6625	-.0268	.2001
IMR_{ANP}	.7810	-.1123	.1825
$NV\text{-}S_A$	.0518	-.3731	.1567
$V\text{-}A_A$	-.0804	-.2168	.0872
CRT_{SR}	.0238	-.1065	.3512
CD_{SR}	.4064	-.0945	-.0213

DT_F	Figural Divergent Thinking	RC_{CNP}	Response Concreteness Concrete Noun Pairs
DT_S	Semantic Divergent Thinking	RC_{ANP}	Response Concreteness Abstract Noun Pairs
UU	Unusual Uses	IMR_{CF}	Imagery Mediation Reports Concrete Figures
SPT_{APT}	Spatial Aptitude (block rotation)	IMR_{AF}	Imagery Mediation Reports Abstract Figures
RO_{CF}	Response Originality Concrete Figures	IMR_{CNP}	Imagery Mediation Reports Concrete Noun Pairs
RO_{AF}	Response Originality Abstract Figures	IMR_{ANP}	Imagery Mediation Reports Abstract Noun Pairs
RO_{CNP}	Response Originality Concrete Noun Pairs	$NV\text{-}S_A$	Non-Verbal-Spatial Activities
RO_{ANP}	Response Originality Abstract Noun Pairs	$V\text{-}A_A$	Verbal-Analytical Activities
RC_{CF}	Response Concreteness Concrete Figures	CRT_{SR}	Creativity Self-Rating
RC_{AF}	Response Concreteness Abstract Figures	CD_{SR}	Dominant Coding Style Self-Rating

TABLE 3

Source Table and Means of Three-Way Analysis of Variance for Task Performance With Level of Objective Spatial Imagery Ability, Level of Self-Report Imagery Mediation, and Type of Performance Task as Factors

	Mean	M.S.	d.f.	F	P
Objective Spatial Imagery Ability		73.73	1/38	.56	.46
Low	49.46				
Hi	50.79				
Self-Report Imagery Mediation:		374.60	1/38	2.88	.09
Low	48.62				
High	51.62				
Type of Task		1.044	1/38	.01	.99
Paired Associate	49.97				
Memory/Designs	50.24				
Semantic Divergent thinking	50.28				
Figural Divergent thinking	50.01				
Objective Spatial X Self-Report Imagery		154.00	1/38	1.18	.28
Lo/Lo	48.92				
Lo/Hi	50.00				
Hi/Lo	48.33				
Hi/Hi	53.22				
Objective Spatial X Type of Task		157.65	1/38	1.76	.15
Lo/PAL	51.45				
Lo/Memory Designs	47.00*				
Lo/Semantic d.T.	49.85				
Lo/figural d.T.	49.55				
Hi/PAL	48.49				
Hi/Memory/Designs	53.48*				
Hi/Semantic d.T.	50.71				
Hi/figural d.T.	50.47				
Self-Report X Type of Task		198.47	1/38	2.22	.08
Lo/PAL	51.29				
Lo/Memory/Designs	49.18				
Lo/Semantic d.T.	46.51*				
Lo/figural d.T.	47.52				
Hi/PAL	48.65				
Hi/Memory designs	51.30				
Hi/Semantic d.T.	54.05*				
Hi/figural d.T.	52.50				
Objective Spatial X Self-Report X Type of Task (See Table 4)		90.77	1/38	1.01	.38

TABLE 4

Performance Task Means and Standard Deviations for Four Mutually Exclusive Imagery Aptitude Groups

	Low Objective Spatial/Low Self Report (N=10)		Low Objective Spatial/High Self Report (N=10)		High Objective Spatial/Low Self Report (N=12)		High Objective Spatial/High Self Report (N=10)	
	M	SD	M	SD	M	SD	M	SD
Paired Associate	53.0	9.1	49.9	12.8	49.5	9.4	47.4	10.2
Memory Designs	48.2	8.5	45.0	9.5	50.1	11.1	56.8	8.3
Semantic Divergent Thinking	48.2	11.7	51.5	7.3	44.8	9.1	56.6	9.4
Figural Divergent Thinking	48.6	10.2	52.8	6.5	48.7	13.1	52.2	9.3

TABLE 5

NONVERBAL COGNITIVE DIMENSIONS

Dimension Mode	Functional Process	Cognitive Product	Measurement
Spatial	Mental manipulation and rotation of external stimuli.	Knowledge of spatial relationships existing among external objects.	External figures manipulated and/or rotated in space in right/wrong matching test format.
Kinetic	Covert body movements.	Internal body space awareness.	Relation of body to given stimulus perspective in right/wrong test format. Self report of body sensation in free response format.
Imaginal	Proximity and configurations of elements in personal experiences.	Nonverbal categorical associations and cognitive representations to affect meaningfulness of thought.	Self-ratings of imagery intensity of presented stimulus. Self-reports of mediators associated with presented stimulus in free response format (verbal to nonverbal continuum advised). Self-report of nonverbal mediation to presented stimulus in timed response format. Nonverbal memory strategy to affect accuracy in recall of presented stimulus in right/wrong test format.

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